

Remarks:

Reconsideration of the application is requested.

Claims 1-10 remain in the application. Claims 1 and 6-10 have been amended.

In the section entitled "Specification" on page 2 of the above-identified Office action, the specification has been objected to because of informalities. Appropriate correction has been made.

In the section entitled "Claim Objections" on page 2 of the above-identified Office action, Claim 10 has been objected to because of an informality. Appropriate correction has been made.

In the section entitled "Claim Rejections - 35 USC § 112" on page 3 of the above-identified Office action, claims 1 and 6-9 have been rejected as being indefinite under 35 U.S.C. § 112 second paragraph.

More specifically, the Examiner has stated that the term "primarily" in claim 1 is a relative term, which renders the claim indefinite. The language of claim 1 has been amended to make it clear that the hydrogen and nitrogen constitute more than 50% of the etching gas composition.

The Examiner has also stated that the meaning of the recitation "for improving etching gas properties in the dry etching process" in claim 6 is not clear. The language of claim 6 has been amended. It is clear that the etching gas composition contains additives which can improve the properties of the etching gas in the dry etching process.

The Examiner has further stated that the recitation "the vertical removal corresponds at most to the etching rate of the organic antireflection layer" in claim 7 is not understood. Claim 7 has been amended to clearly recite that the rate at which the photoresist is removed in a vertical direction does not exceed the etching rate of the organic antireflection layer.

The Examiner has additionally stated that in the recitation "flow of the etching gases in a range between 0.17 and $1.67 \cdot 10^{-6} \text{ m}^3 \text{ sec}^{-1}$ " in claim 8, the 10^{-6} does not appear to be associated with the 0.17. Appropriate correction has been made.

The Examiner has further additionally stated that claim 9 includes mutually exclusive limitations in that it requires processing with magnetic field-assisted reactive ion etching while at the same time allowing for a magnetic field strength

of 0 Gauss. Claim 9 has been amended to exclude the strength of 0 Gauss.

It is accordingly believed that the specification and the claims meet the requirements of 35 U.S.C. § 112, second paragraph. Should the Examiner find any further objectionable items, counsel would appreciate a telephone call during which the matter may be resolved. The above-noted changes to the claims are provided solely for cosmetic and/or clarificatory reasons. The changes are neither provided for overcoming the prior art nor do they narrow the scope of the claims for any reason related to the statutory requirements for a patent.

In the section entitled "Claim Rejections - 35 USC § 102" on page 4 of the above-identified Office action, claims 1, 2, 4 and 5 have been rejected as being anticipated by Chen et al. (US Pat. No. 6,211,061) under 35 U.S.C. § 102(e). In the section entitled "Claim Rejections - 35 USC § 103" on pages 4-7 of the above-identified Office action, claims 6-10 have been rejected as being unpatentable over Chen et al. under 35 U.S.C. § 103(a); claims 6 and 10 have been rejected as being unpatentable over Chen et al. and further in view of Ellingboe et al. (US Pat. No. 6,114,250) under 35 U.S.C. § 103(a).

Enclosed please find a Declaration under 37 CFR 1.131 together with a copy of the "Invention Disclosure"

("Erfindungsmeldung"), a report of the invention by the inventors prepared on **October 26, 1999**, which date is before the filing date **October 29, 1999** of Chen et al. The document Chen et al. is therefore not available as a prior art reference for the instant application. Therefore, Applicants respectfully submit that the Section 102 and Section 103 rejections on pages 4-7 of the Office action are now moot.

In view of the foregoing, reconsideration and allowance of claims 1-10 are solicited.

In the event the Examiner should still find any of the claims to be unpatentable, counsel would appreciate a telephone call so that, if possible, patentable language can be worked out.

Please charge any fees which might be due with respect to Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,

For Applicants

YHC:cgm

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Marked-Up Version of the Amended Paragraphs in the Specification and Marked-Up Version of the Amended Claims:

The paragraph starting on page 3, line 6 and ending on page 4, line 4 now reads as:

One variant of the photoresist technique with an antireflection layer is what is referred to as the trilevel resist technique. Here, a so-called bottom resist layer is sputtered onto the semiconductor substrate. The bottom resist layer is a positive resist or its [resewherein] resin which can be made highly light-absorbing by the addition of an absorber or by high baking out. Onto this so-called bottom resist layer, a spin-on-glass intermediate layer and then a so-called top resist layer are applied. This topmost top resist layer is the actually photochemically active layer. The bottom resist layer, on the other hand, ensures that virtually no light is reflected back from the semiconductor substrate into this top resist layer. In addition, the bottom resist layer is also made sufficiently thick to level any steep steps which are present on the semiconductor substrate, so that the top resist layer can be sputtered on with a uniform thickness which is not influenced by these surface steps. The top resist layer is then exposed and developed via a mask which contains the desired semiconductor component structure. As a result of the development, the top resist layer is dissolved at the exposed

points while the non-irradiated areas remain masked. The spin-on-glass intermediate layer is then etched at the exposed points. The latter is then used as an etching mask during the anisotropic etching of the bottom resist layer which is finally in turn used as a masking layer for etching the semiconductor layer, for example silicon dioxide, which lies underneath and is to be structured.

The paragraph starting on page 9, line 22 and ending on page 10, line 10 now reads as:

In accordance with a further feature of the invention, a photoresist layer is used as an etching mask for the organic antireflection layer, and the etching gas composition is adjusted such that [a vertical removal of] a rate at which the photoresist is removed in a vertical direction corresponds at most to an etching rate of the organic antireflection layer. In this embodiment, when a photoresist layer is used as the etching mask for the organic antireflection layer, the etching gas composition with hydrogen and nitrogen is set such that the vertical removal corresponds at most to the etching rate of the organic antireflection layer. This achieves the situation where only slight faceting of the photoresist layer used as the etching mask occurs during the etching process, and the organic antireflection layer lying underneath continues to have steep edges after the etching process.

The paragraph starting on page 10, line 12 and ending on page 10, line 23 now reads as:

In accordance with again a further feature of the invention, the physical/chemical dry etching with a reaction gas mixture of hydrogen and nitrogen is carried out using reactive ion etching technique in a pressure range of 2.67 to 26.67 Pa (20 to 200 mTorr) and with a gas flow of $0.17 \text{ } 10^{-6}$ to $1.67 \text{ } 10^{-6} \text{ m}^3\text{sec}^{-1}$ (10 to 100 sccm). During such an etching process, the etching behavior can be controlled particularly well with regard to homogeneity, etching rate, etching profile and selectivity and, in addition, high reproducibility can be achieved. It is also preferred to carry out the reactive ion etching with the assistance of a magnetic field, in a magnet field of up to 120 Gauss.

The paragraph starting on page 16, line 18 and ending on page 17, line 17 now reads as:

Using control electronics on the reactor, the pressure and the gas flow rate are kept substantially constant. The pressure range for etching the organic antireflection layer 3 is preferably in the range from 2.67 to 26.67 Pa (20 to 200 mTorr). The gas flow rate is preferably set to a value within the range from $0.17 \text{ } 10^{-6}$ to $1.67 \text{ } 10^{-6} \text{ m}^3\text{sec}^{-1}$ (10 to 100 sccm). By means of an applied high voltage, the etching gas mixture

between the electrodes 20, 50 is caused to form a glow discharge. A low-pressure low-temperature plasma with ions and electrons is formed. Since the upper electrode 20 is connected to the vacuum chamber 10 and grounded, the upper electrode 20 has a greater surface than the lower electrode 50. This results in the lower electrode 50 being charged up more negatively than the upper electrode 20. On the way to the semiconductor wafer to be etched, the ions from the plasma are therefore given sufficient kinetic energy to trigger a chemical reaction with the organic antireflection layer 3. They pass vertically to the surface to be etched and in this way transfer the mask predefined by the photoresist layer 4 into the organic antireflection layer while maintaining the dimensions. The etching is preferably assisted, as shown in Fig. 2, by a magnetic field which is generated by magnets 90 in the vacuum chamber 10. The magnetic field compresses the plasma over the layer to be etched. As a result, the number of ions available for etching is increased significantly. A magnetic field of up to 120 Gauss can be used.

The paragraph starting on page 18, line 18 and ending on page 19, line 16 now reads as:

Furthermore, the use of the hydrogen/nitrogen chemistry permits the etching of the semiconductor layer lying under the organic antireflection layer, wherein etching process the

organic antireflection layer serves as a masking layer in one and the same etching reactor. The etching of the silicon dioxide layer, generally lying underneath the organic antireflection layer, is preferably likewise carried out by means of magnetic field-assisted reactive ion etching, a typical oxide etching process being carried out with the following process conditions. The pressure in the vacuum chamber is about 20 Pa (150 mTorr). The etching gases used are $[\text{CHF}_3]$ CHF_3 and $[\text{CF}_4]$ CF_4 , the gas flow being $0.58 10^{-6} \text{ m}^3 \text{ sec}^{-1}$ (35 sccm) or $0.42 10^{-6} \text{ m}^3 \text{ sec}^{-1}$ (25 sccm). In addition, to improve the etching behavior, argon is fed in at a flow rate of $2.5 10^{-6} \text{ m}^3 \text{ sec}^{-1}$ (about 150 sccm). The magnetic field for assisting the etching is preferably 15 Gauss. Using the chemistry previously used as standard for etching the organic antireflection layer, the subsequent etching of an oxide layer lying underneath was not possible in the same etching chamber, since the chemistry for etching the organic antireflection layer was incompatible with the chemistry of the following oxide etching. The use according to the invention of the hydrogen/nitrogen chemistry, which permits the etching chamber used for this purpose to be used for the subsequent oxide etching, achieves a significant time-saving and cost-saving effect.

Claim 1(amended). A process for anisotropically dry etching of an organic antireflection layer, which comprises etching

the organic antireflection layer with an etching gas composition [primarily] containing hydrogen and nitrogen as majority components.

Claim 6 (amended). The process according to claim 1, [which comprises etching with an] wherein the etching gas composition [containing] contains additives for improving etching gas properties in the dry etching process.

Claim 7 (amended). The process according to claim 1, which comprises using a photoresist layer as an etching mask for the organic antireflection layer, and setting the etching gas composition [such that] for causing a vertical removal of the photoresist [corresponds] at most corresponding to an etching rate of the organic antireflection layer.

Claim 8 (amended). The process according to claim 1, which comprises setting the following process parameters for the reactive ion etching of the organic antireflection layer:

pressure of the etching gases in a range between 2.67 and 26.67 Pa; and

flow of the etching gases in a range between 0.17 10^{-6} and 1.67 10^{-6} $m^3 sec^{-1}$.

Claim 9 (amended). The process according to claim 8, which comprises exposing an etching object to a magnetic field strength from above 0 to 120 Gauss and processing the object with magnetic field-assisted reactive ion etching.

Claim 10 (amended). The process according to claim 1, which comprises etching the organic antireflection layer with a plasma from a source selected from the group consisting of an electron cyclone resonance plasma source, an inductively coupled plasma, [or] and a Helicon source.